Overcoming Joint Interoperability Challenges

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The expanding variety of ground, surface, and air platforms with Tactical Data Link (TDL) capabilities and the increasing reliance on joint, allied, and coalition forces have driven a growing demand for TDL interoperability training. For decades, the TDLs that combine to form the Multi-TDL Network (MTN) have increased situational awareness while decreasing targeting and decisionmaking timelines for aviation and maritime component commanders, air defense commanders, aircrews, and recently, tactical air control parties. Technological advancements continue to increase the range and mobility of weapons systems; decrease the time required to detect, decide, deliver, and assess; and facilitate near-real-time command and control (C2) from beyond line of sight. Reviewing the communications, concepts, technology, and applications that developed into TDL capabilities leading up to the MTN brings current and future joint interoperability challenges and training requirements into perspective.

Evolution

According to David L. Woods in *A History of Tactical Communication Techniques*, "Since wars began, commanders have sought effective two-way communication directly on the battlefield. The enemy must be located, his strength must be determined, and the field commander must receive this information promptly. Then, based on this information, the commander's instructions must reach his men."[1] Prior to the invention of electrical telecommunications in the 1830s, commanders relied on what they could see with their own eyes and information received via couriers to create and update their maps and terrain models to support operational and tactical planning and decisionmaking. The telegraph and later the telephone and radio enabled commanders to receive more timely updates. During the U.S. Civil War, balloons initially helped make maps more accurate. However, on at least one occasion a balloon was used to direct artillery fire from a Union location without line of sight to a Confederate encampment. The balloon, named *Eagle*, was attached via tether and telegraph to Fort Corcoran near Falls Church, Virginia.[2] A Union artillery battery was located at the easterly advance to the fort. In this incident, through use of a series of predetermined flag signals, artillery fire was directed at the nearby Confederate encampment until the shots landed on target. This was a first among the foundational communications concepts that would evolve into modern TDL applications.[3]

The integration of air defense assets during World War II also formed a conceptual basis for sharing tactical data. The United Kingdom (UK) integrated Chain Home radar stations, observer posts, air defense artillery batteries, and Royal Air Force intercept squadrons via an extensive wire and radio communications system. Voice cross telling of aircraft position data effectively integrated or linked the air defense network and was the key to the UK's survival and victory. At the strategic planning core of the British integrated air defense system, radar plots were correlated to provide range and direction of raids from radar by triangulation. Positive control became possible by using radar plots, identification, friend or foe (IFF), signals from squadrons in the air, and high frequency and later clear very high frequency radio transmissions. Aircraft were directed by sector controllers until enemy aircraft were within visual contact, at which point the squadron commanders assumed control of the air battle. By 1943 aircraft losses required the German Luftwaffe to end offensive operations and focus almost exclusively on defense of the home territory.[4]

The use of radar generated large amounts of information about enemy locations; however, in the early days of radar, this information was displayed by way of the sensor's organic display or manually generated drawings and models. Transmitting this information between operations centers required voice communications to cross tell information among plotters who manually transcribed aircraft locations and tracks onto maps. The development of data communications and automation in the decades following World War II not only enhanced the timeliness and accuracy of communications, increasing speed to real-time or near-real-time, but also enabled more information about friendly and enemy forces and other entities to be transmitted along with track data.

The post–World War II period saw an increased need for the ability to disseminate information more quickly

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and with greater precision. Whereas air defense artillery and defensive air formations used radio to communicate voice commands to cue their fires on incoming enemy planes, jets and rockets moving at supersonic speeds required information exchanges that supported not only the commander's decisionmaking but also the pilots engaged in the fight. Building toward that end, arguably the first modern TDL, known today as Link 11, was introduced about 1955.

TDL

Link 11, once known as TADIL A and now often referred to as TDL A, provided warfighters the capability to disseminate track data and other information using a roll-call method, where a network control station sends and receives information sequentially from network participants. If a participating unit does not answer the first time, the information exchange cycle is lengthened as the computers keep seeking a response before moving to the next participant. While improving the speed of information exchange, it was implemented within larger C2 platforms and did not share information with smaller platforms such as fighter aircraft. Furthermore, Link 11 lacked the capacity to pass the volume of information that later surveillance systems such as the Airborne Warning and Control System (AWACS) could generate. The requirements for greater information volume or bandwidth, speed of transmission and reception, information assurance (encryption), and jam resistance were addressed with the advent of Link 16.

The earliest derivative of Link 16, also known as TDL J, was introduced in the late 1970s. Link 16 not only enhanced warfighters' capability of near-real-time dissemination of critical information such as locations and directions of blue and red force aircraft movements, but also enabled the exchange of additional data regarding platform and weapons status, bomb damage assessment, and other mission critical information. Link 16 has become part of the digital communications architecture for U.S. and some allied forces to find, fix, track, target, engage, and assess ballistic missiles. At the heart of Link 16 are the Joint Tactical Information Distribution System/Multifunctional Information Distribution System (JTIDS/MIDS) radios that transmit data according to a language known as J series messages using Time Division Multiple Access protocols that enable multiple users to send and receive information seemingly simultaneously in programmed timeslots.[5]

Specific JTIDS/MIDS platform timeslot programming is based on a given network participant's roles and responsibilities. For example, an AWACS aircraft tracks objects in the air via its radar and constantly sends updated track information to fighters under its control, Air Defense Artillery units, or other C2 agencies such as the Marine Corps' Tactical Air Command Center. The Link 16 network programming instructions for the AWACS would include sufficient timeslot assignments to meet mission requirements and expected information volume. Other platforms in the network that require this information would be programmed to receive at sufficient intervals to meet their mission requirements. Numerous JTIDS/MIDS-equipped Link 16 platforms were designed with the ability to forward data between Link 11 and various other links, essentially making Link 16 the backbone of what is known as the Multi-TDL Network.

The MTN and Interoperability

Doctrinally, the TDLs comprising the MTN are Links 16, 11, and 11B as the primary interfaces. The MTN also includes extended interfaces such as the Situation Awareness Data Link, Link 22, Army Tactical Data Link, and North Atlantic Treaty Organization Link 1. The MTN is among the networks that feed into the databases that produce the common operational picture and common tactical pictures. TDLs have been primarily employed by assets of the air and maritime components; however, land and special operations components with new and varied tactical platforms, along with allied and coalition partners, are increasing their participation in the MTN.

The MTN will be in use for the foreseeable future. The use of Link 16, in particular, will expand to include emerging capabilities such as net enabled weapons, TDL-equipped rotary-wing aircraft and unmanned aircraft systems, and integrated air and ballistic missile defense platforms. In this last emerging capability, the MTN will support multiple systems and decisionmakers to better address the missile threat. This expansion into new areas presents interoperability challenges for network designers and warfighting planners as the capabilities and complexity of C2 information systems increase.

Interoperability is "the ability of systems, units, or forces to provide services to and accept services from other systems, units, or forces and to use the services so exchanged to enable them to operate effectively together."[6] Interoperability among maneuvering joint, allied, and coalition forces with diverse and dynamic organizational structures, along with expanding TDL capabilities and applications, implies numerous challenges. Fielding new and varied TDL equipment and applying new tactics, techniques, and procedures (TTP) can enhance interoperability; however, this is a double-edged sword due to the effects on MTN Information Exchange Requirements (IERs).[7]

IERs are "essential to command and control; enabling the situational needs of the joint task force and component commanders to support force employment and decision making."[8] IERs identify who will exchange data, what data will be exchanged, why the data are important, and how data will be exchanged. Fulfilling the operational commanders' IERs contributes to the situational awareness needed for decisions on the maneuver of forces and use of resources. At the tactical level, fulfilling IERs informs critical decisions that lead up to and include targeting the enemy. The timeliness requirements of an IER are related to the speed of decisionmaking needed to achieve desired effects. How the data will be exchanged depends on factors that include the volume or bandwidth needed, geographic locations, equipment capabilities and limitations,

TTPs, and security concerns. Operational effects on IERs, including increases in theater size, range of the weapons systems, active environments, number of TDL platforms, amounts of data, and fidelity requirements, along with decreases in the time to discover, decide, and act, combine with lag-times in the acquisition process to further compound interoperability problems. Figure 1 shows operational effects on IERs.

The acquisition process creates baseline changes intended to improve TDL platform capabilities to fulfill existing and emerging IERs. In the process, one set of equipment may advance ahead of the others. Maintaining interoperability with legacy or old-technology equipment often requires a patch, which may come in the form of a forwarding capability where messages are translated from one format or standard to another—for example, when several Link 16 capable platforms are also capable of forwarding data via Link 11 and Link 11B. Unfortunately, some data loss occurs in this process because legacy TDLs are not designed to handle as much information as Link 16. The myriad of changing TDL system capabilities and limitations, numerous workarounds, and IERs that must be facilitated to ensure interoperability requires a staff that includes trained Joint Interface Control Officers (JICOs), MTN planners, and TDL operators. Figure 2 depicts acquisitions lag-time and workarounds.

Each combined or joint component headquarters, usually the Air Component headquarters responsible for the preponderance of C2 and communications capabilities, includes a Joint Interface Control Cell (JICC), led by a JICO, whose primary duty is the overall management of the MTN to meet commanders' IERs. The JICO is usually an O-3 or O-4 and manages the MTN across component, Service, and national lines by direct liaison authority. The authority and functionality of the JICO and JICC are based on expertise from training and experience as well as cooperation derived from joint doctrinal relationships, TTPs, lessons learned, best practices, and precedence.

Figure 1. Operational Effects on IERs

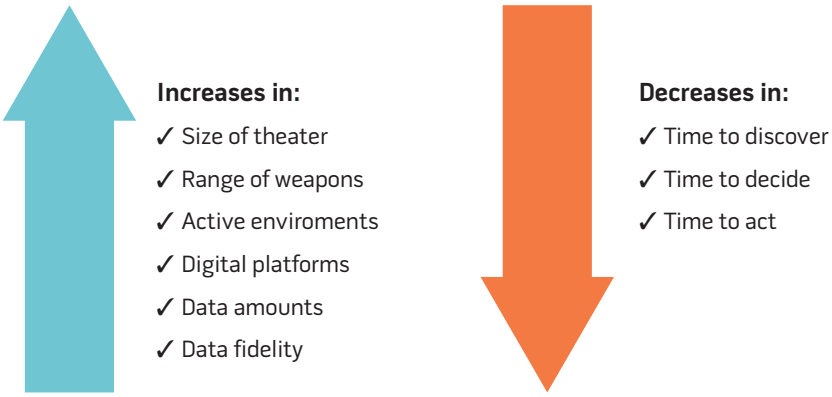
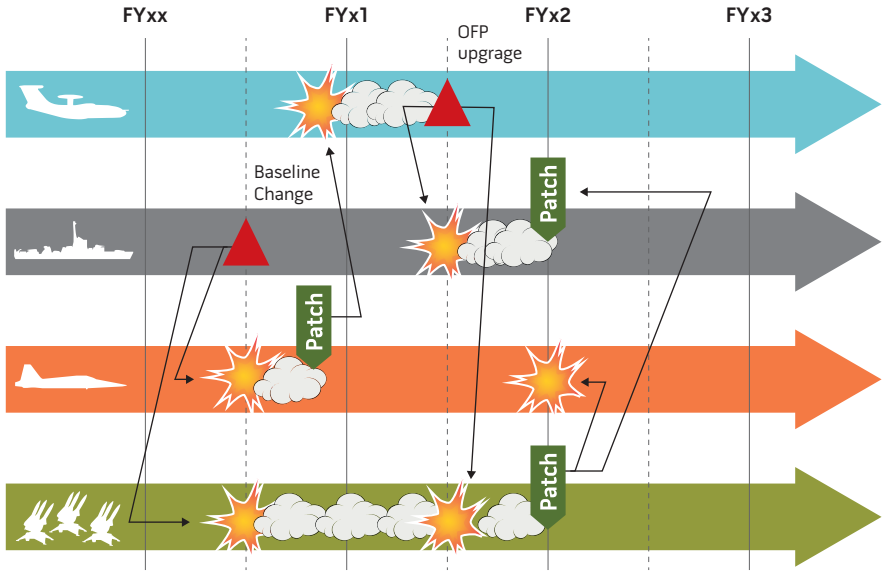


Figure 2. Acquisitions Lag-Time and Workarounds



Training

The complexity of the MTN requires JICOs and a wide variety of MTN planners and TDL operators. These planners and operators are highly technically trained to meet IERs and mitigate the myriad of TDL interoperability problems associated with the various joint and coalition systems. They do this to maximize MTN capabilities across U.S., coalition, and allied platforms and rely on a mix of modern and legacy TDL equipment. MTN operators and planners include both officers and enlisted. They are found in a variety of occupational fields including air defense, aviation, C2, and communications. Additionally, an increasing number of allied and coalition partner nations, including the UK, Australia, Saudi Arabia, and Japan, to name a few, are using Link 16 and legacy TDLs along with other MTN capabilities.

There is only one Department of Defense (DOD) organization for joint and coalition training of MTN operators, planners, JICOs, and JICC personnel. The Joint Staff J7, Joint Interoperability Division (JID)—with a staff of fewer than 60 total personnel comprised of Active-duty military, DOD civilians, and contractors—trains U.S. personnel from the joint combatant commands, Services, and DOD agencies (C/S/As) as well as

How to Request Support

The Joint Interoperability Division (JID) Joint Interoperability Training Center is located on Pope Army Air Field, Fort Bragg, North Carolina. Personnel from joint combatant commands, the Services, and Department of Defense (DOD) agencies who want training or Tactical Data Link (TDL)/Multi-TDL Network support should contact their respective Service quota managers or network design facilities:

- Army: DSN 312-424-7725, Comm 910-394-7725
- Marine Corps: DSN 312-424-1172, Comm 910-394-1172
- Navy Detailer: training en route to PCS, DSN 312-882-3906, Comm 901-874-3906
- Navy East Coast: Fleet Forces Command (quota manager for 2nd, 4th, and 6th Fleets), DSN: TBD, Comm: 757-445-1561
- Navy West Coast: 3rd Fleet (quota manager for 3rd, 7th, and PACFLT), DSN 312-577-4317, Comm 619-767-4317
- Air Force: HQ ACC/A3YJ, DSN 574-8328/29, Comm 757-764-8328/29
- Joint billeted military, DOD civilians (General Schedule), DOD-sponsored contractors, and other U.S./U.S. Government personnel or general JID inquiries: Joint Staff J7/JED/JID, DSN 312-424-1209, DSN FAX 312-424-1208, Comm 910-394-1209/1208.

Two JID courses are offered on the Web via Joint Knowledge Online (JKO) for anyone with a U.S. Government Common Access Card:

- Link 16 Basics Course (J7S-JT100)
- Link 16 Joint Interoperability Course (J3OP-US109/US109LB).

Both are available at <https://jkodirect.jten.mil/Atlas2/faces/page/login/Login.seam>.

Additionally, the JID maintains a large Web presence with information about the latest course schedules and contact information at the sites:

- Facebook at <www.facebook.com/#!/pages/Joint-Interoperability-Division/13426208344744242>
- milSuite at <www.milsuite.mil/book/groups/joint-interoperability-division-jid>
- U.S. Message Text Format Community of Interest on JKO (via Army Knowledge Online) at <www.us.army.mil/suite/page/524917>
- Fort Bragg Public Affairs Officer at <http://pao.bragg.army.mil/units/JID/Pages/default.aspx>
- JID Community of Interest on JKO (via Army Knowledge Online) at <www.us.army.mil/suite/page/508203>
- Joint Electronic Library+ at <https://jdeis.js.mil/jdeis/index.jsp?pindex=100>
- LPDS at <https://lpds.jten.mil/>.

coalition and allied partners through the Foreign Military Sales process. The sidebar shows how to request support.

The JID is organized into three branches to provide joint and coalition MTN training as well as MTN support to the global combatant commands (GCCs): the Joint Multi-TDL School (JMTS) for Joint/U.S. MTN training; Operations Support Branch (OSB) for U.S. JICO training and GCC support; and Allied Training Branch (ATB) for allied and coalition MTN and JICO training. A single education and training curriculum and development process ties these branches together and ensures standardization and currency of information among all courses. The JMTS provides expert Joint Multi-TDL and U.S. Message Text Format training to approximately 1,450 students annually in support of C/S/As. The OSB builds on JMTS training to provide operational tactical data link interface support and training to GCCs and the Services and has trained over 530 JICOs and JICC operations personnel since 2004. The ATB leverages the JMTS curriculum to develop and conduct TDL interoperability training in accordance with foreign disclosure policies for allied and coalition partner nations through Foreign Military Sales via Mobile Training Teams. In 2013, the ATB trained 547 foreign students.

Joint interoperability training within the JID is multifaceted, covering operational, system, technical, and procedural aspects. JID courses touch on all levels of interoperability. JID training progresses from advanced Link 16 and MTN operations through joint MTN planning and culminates with TDL career capstone courses to train GCC and joint task force JICOs and advanced JICC operators. Students are presented scenarios that include MTN-capable units, platforms and systems from all Services, and a diverse sampling of allied and coalition partner nations. The training emphasizes the Multi-TDL Architecture (MTA) and MTN operations to account for and leverage the differences in TDL capabilities and TTPs. The JID's TDL interoperability training produces graduates who understand the process of designing interoperable MTAs that enable MTN operations to meet the commanders' IERs in an allied/coalition operating environment.

The JID, through its three branches, has trained more than 20,000 DOD personnel in joint interoperability since its inception in 1979. Allied and coalition interoperability training began in 2004, and more than 3,200 personnel from partner nations have been trained to be interoperable with U.S. forces in combined operations. More than 5,800 total personnel representing all MTN participating C/S/As and many allied/coalition nations have been trained in TDL interoperability since the JID was assigned to the Joint Staff J7 in 2011. Since 2011, a savings of more than $4.6 million in temporary duty assignment funds has been realized by DOD due to JID Joint Mobile Training Teams taking MTN interoperability training to more than 800 joint students in the various GCC areas of responsibility.

The JID maintains a relevant and evolving Joint Tactical Operations Interoperability Training program that is responsive to C/S/A training

requirements, including student throughput demand. Weekly teleconferences, the annual JICO Symposium, Chairman of the Joint Chiefs of Staff Instruction–mandated Joint Training Committee meetings, and exercise and training planning conferences maintain a routine and recurring dialogue and exchange of information with C/S/As. These venues combined with friendly exchanges between members of the JICO and TDL operators' professional community—such as Service network design facilities, training quota managers, various platform/TDL subject matter experts, JID students, and JID cadre—keep the JID apprised of the latest developments in doctrine, TTPs, and TDL system capabilities and limitations. The JID continues to develop and train joint, allied, and coalition personnel to meet the dynamic joint interoperability challenges within the MTN after nearly four decades. JFQ

Notes

[1] David L. Woods, *A History of Tactical Communication Techniques* (Orlando, FL: Martin-Marietta Corp., 1965).

[2] The capability of using the telegraph from a balloon was developed in June 1861.

[3] *Appleton's Annual Encyclopedia and Register of Important Events of the Year: 1862* (New York: D. Appleton & Company, 1863), 184.

[4] Charles G. Crawley, *How Did the Evolution of Communications Affect Command and Control of Airpower 1900–1945?* (Carlisle Barracks, PA: U.S. Army War College, April 1, 1996).

[5] J2.0 Indirect PPLI, J2.2 Air PPLI, J2.X Surface PPLI, J2.5 Land PPLI, J3.2 Air Track, J3.3 Surface Track, J3.5 Land Track/Point, and so forth.

[6] Joint Publication 1-02, *Department of Defense Dictionary of Military and Associated Terms* (Washington, DC: The Joint Staff, November 8, 2010, as amended through March 15, 2014).

[7] Chairman of the Joint Chiefs of Staff Memorandum 3115.01C, "Joint Data Network (JDN) Operations: Volume I," November 16, 2011.

[8] Ibid.

Joint Publications (JPs) Under Revision (to be signed within 6 months)

JP 2-01.3, *Joint Intelligence Preparation of the Operational Environment*

JP 3-02, *Amphibious Operations*

JP 3-02.1, *Amphibious Embarkation and Debarkation*

JP 3-05, *Special Operations*

JP 3-09.3, *Close Air Support*

JP 3-10, *Joint Security Operations in Theater*

JP 3-13.2, *Military Information Support Operations*

JP 3-26, *Counterterrorism*

JP 3-40, *Countering Weapons of Mass Destruction*

JP 3-52, *Joint Airspace Control*

JP 3-63, *Detainee Operations*

JP 4-10, *Operational Contract Support*

JPs Revised (signed within last 6 months)

JP 1-05, *Religious Affairs in Joint Operations* (November 20, 2013)

JP 2-0, *Joint Intelligence* (October 22, 2013)

JP 3-06, *Joint Urban Operations* (November 20, 2013)

JP 3-07.2, *Antiterrorism* (March 14, 2014)

JP 3-11, *Operations in Chemical, Biological, Radiological, and Nuclear Environments* (October 4, 2013)

JP 3-24, *Counterinsurgency* (November 22, 2013)

JP 3-29, *Foreign Humanitarian Assistance* (January 3, 2014)

JP 3-30, *Command and Control for Joint Air Operations* (February 10, 2014)

JP 3-31, *Command and Control for Joint Land Operations* (February 24, 2014)

JP 4-0, *Joint Logistics* (October 16, 2013)

JP 4-05, *Joint Mobilization Planning* (February 21, 2014)

JP 4-09, *Distribution Operations* (December 19, 2013)